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BY

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Biological exploration of México and Central America has revealed the presence of a diverse fauna, elements of which have undergone speciation in separate areas within the relatively small region. Some genera of amphibians, especially *Eleutherodactylus* and *Hyla*, are represented by many species having small geographic ranges in México and Central America. Most of the species of *Hyla* inhabiting the lowlands have been known to science for many years, and most of the novelties today are found in the less accessible highlands. No fewer than 19 new species of hylid frogs have been discovered and named from México and Central America in the past decade.

In the spring and summer of 1966 I studied hylid frogs in many parts of southern México and Central America; the field work was designed to obtain specimens and data that would resolve certain systematic problems. To a certain extent the studies were successful, but in the course of the work five previously unknown hylids were discovered; these are named and described in this paper. The only species described herein that I do not know in life is one of *Plectrohyla* that has been represented in museum collections for several years but was not obtained in my own field work.

In this paper I am presenting diagnoses, descriptions, and brief comments on the relationships of five new species and one subspecies. More exhaustive accounts will be included in a monograph, now in preparation, on the Middle American hylids.

For use of comparative material used in the preparation of this paper, I am indebted to Richard J. Baldauf, Texas Cooperative Wildlife Collection (TCWC); Charles M. Bogert, American Museum of Natural History (AMNH); James A. Peters, United States National Museum (USNM); Hobart M. Smith, University of Illinois Museum of Natural History (UIMNH); Charles F. Walker, University of Michigan Museum of Zoology (UMMZ); and Ernest E. Williams, Museum of Comparative Zoology (MCZ). KU refers to the University of Kansas Museum of Natural History. I am

especially grateful for help in obtaining specimens and data to Linda Trueb, who accompanied me throughout México and Central America, where we were joined by John D. Lynch in Costa Rica and Charles W. Myers in Panamá. Linda Trueb offered helpful suggestions in the course of preparing the manuscript, and David M. Dennis skillfully prepared the illustrations which more accurately depict the frogs than my written descriptions; both of these persons have my thanks for their contributions.

Ratibor Hartmann of Finca Santa Clara, Chiriquí, Panamá, made possible our travels to the Río Changena on the Atlantic slopes of Bocas del Toro. Field work in Costa Rica was facilitated by the Organization of Tropical Studies through the courtesy of Stephen B. Preston and Norman Scott. Rodolfo Hernandez Corzo of the Dirección General de la Fauna Silvestre provided the necessary permits to collect in México. I thank each of these persons for his helpfulness and cooperation.

Field work in México and Central America and the associated laboratory studies on Middle American hylid frogs are supported by grants from the National Science Foundation (GB-1441 and GB-5818). The field work in Panamá was part of a survey of the herpetofauna of that country carried out in cooperation with the Gorgas Memorial Laboratory and supported by the National Institutes of Health (GM-12020).

Hyla xanthosticta new species

Plate 17

Holotype.—Adult female, KU 103772, from the south fork of the Río Las Vueltas on the south slope of Volcán Barba, near the northwest base of Cerro Chompipe, Heredia Province, Costa Rica, elevation 2100 meters; obtained on June 26, 1966, by John D. Lynch.

D'agnosis.—A member of the *Hyla pictipes* group (Starrett, 1966), characterized by having dorsum uniform green, canthal stripe bronze-color, flanks and anterior and posterior surfaces of thighs dark brown with bright yellow spots, throat and belly yellow, and hands having only vestigial web.

Description of holotype.—Female having a snout-vent length of 29.3 mm.; tibia length 16.2 mm., 55.3 per cent of snout-vent length; foot length (measured from proximal edge of inner metatarsal tubercle to tip of longest toe) 14.1 mm., 48.1 per cent of snout-vent length; head length 10.0 mm., 34.1 per cent of snout-vent length; head width 10.3 mm., 35.2 per cent of snout-vent length. Snout in lateral profile truncate, slightly inclined posteroventrally, in dorsal profile narrow but truncate; canthus angular; loreal region barely concave; lips thick, barely flared. Snout long; distance from anterior corner of eye to nostril equal to diameter of eye; nostrils slightly protuberant, directed laterally; internarial distance, 2.6 mm.; internarial area slightly depressed; top of head

slightly convex; interorbital distance 3.2 mm., 31.1 per cent of width of head; width at eyelid 2.6 mm.; 24.3 per cent of width of head. Diameter of eye 3.0 mm.; thin dermal fold extending posteriorly from posterior corner of eye, above tympanum, to point above insertion of arm. Tympanum distinct, its diameter half that of eye.

Axillary membrane absent; arms slender; thin scalloped dermal fold on ventrolateral edge of forearm; thin dermal fold on wrist; fingers long, tapering; length of fingers from shortest to longest, 1-2-4-3; discs small, only slightly wider than digits; subarticular tubercles large; distal tubercle on third finger broad, flat; distal tubercle on fourth finger strongly bifid; supernumerary tubercles large, round, closely spaced irregularly on proximal segments of digits; prepollex moderately enlarged. Web lacking between first and second fingers, vestigial between second and third fingers, extending from middle of antepenultimate phalanx of third to base of penultimate phalanx of fourth. Heels overlap by about one-third length of shank when hind limbs adpressed; tibio-tarsal articulation extends to anterior edge of eye; thin transverse dermal fold on heel; scalloped dermal fold along outer edge of tarsus; inner metatarsal tubercle large, flat, elliptical, visible from above; toes long, slender; length of toes from longest to shortest, 1-2-5-3-4; discs small, barely wider than digits; subarticular tubercles large, round, subconical; supernumerary tubercles few, scattered on proximal segments of digits; toes about two-thirds webbed; webbing extending from middle of penultimate phalanx of first toe to middle of penultimate phalanx of second, from distal end of penultimate phalanx of second to base of penultimate of third, from distal end of penultimate phalanx of third to middle of antepenultimate of fourth to middle of penultimate of fifth toe.

Anal opening directed posteroventrally at level of mid-thigh, bordered below by large tubercles; anal sheath lacking. Skin smooth on dorsum except for small scattered tubercles, granular on belly and posteroventral surfaces of thighs. Tongue round, emarginate, barely free behind. Prevomerine teeth 5-5, on large ovoid elevations at level of posterior edges of small round choanae.

Color (in preservative): dark purplish brown above, brown on limbs; first three fingers and first three toes creamy yellow; other digits brown; flanks dark brown with white spots; anterior and posterior surfaces of thighs and inner surfaces of shanks brown with cream-colored spots. White stripes on edge of upper lip, ventrolateral edge of forearm, outer edge of tarsus, and above anus. Chin and throat white; belly and ventral surfaces of limbs cream-color.

Color (in life): dorsum green, palest on sides of head; dorsal surfaces of thighs tan; canthal stripe bronze-tan (reddish copper at night); flanks, anterior and posterior surfaces of thighs, and inner surfaces of tarsi brown with bright yellow spots. Throat and belly pale yellow; ventral surfaces of limbs dull, dark yellow; large, bright yellow spot on anteroventral surface of thigh; bright yellow tubercles on median part of ventral surface of thigh. Anal area dark brown with white stripe above and yellow stripe below; white stripe on outer edge of forearm, outer edge of tarsus, and edge of upper lip. Iris gold-color with fine black reticulations and faint reddish suffusion medially; palpebral membrane clear.

Comparisons.—*Hyla xanthosticta* is a member of the *Hyla pictipes* group that contains *debilis*, *pictipes*, *ricularis*, and *tica*. From all of these, *xanthosticta* differs by having large yellow spots on the flanks and thighs, a white

labial stripe, and a large yellow spot on the proximal ventral surface of each thigh. Females of *Hyla pictipes* have small creamy yellow spots on the flanks and thighs but have dark spots on the venter; furthermore, *pictipes* lacks white stripes on the upper lip and above the anus, lacks a canthal stripe, and has larger discs and less webbing on the hand. *Hyla tica* differs from *xanthosticta* by having white mottling on the flanks, dark transverse bands on the limbs, and larger discs, and lacks yellow spots on the thighs, and white stripes on the upper lip, limbs, and above the anus. *Hyla rivularis* is notably different in having a tan dorsum and creamy yellow venter with black flecks; moreover, *rivularis* lacks spots on the flanks and thighs and white stripes on the upper lip, limbs, and above the anus. Of all of the species in the *pictipes* group, *xanthosticta* most closely resembles *debilis*. This species has a dull green dorsum, usually flecked with brown or black, and a creamy white venter. The flanks of *debilis* are creamy white with small brown flecks, and the anterior and posterior surfaces of the thighs are bright yellow. *Hyla debilis* has a dull tan canthal stripe and white spots on the upper lip; the webbing on the hand is slightly more extensive, and the discs are slightly larger, in *debilis* than in *xanthosticta*.

The presence of the large yellow spots on the flanks and thighs in combination with the uniformly green dorsum and yellow venter immediately distinguishes *Hyla xanthosticta* from all other known species of Middle American hylids.

Remarks.—The only known specimen of *Hyla xanthosticta* was perched at night on a leaf about one meter above the ground. The frog was found in humid upper montane forest characterized by large oaks supporting many bromeliads and heavy growths of mosses. Two other members of the *Hyla pictipes* group—*pictipes* and *rivularis*—were abundant along a stream in the oak forest.

The specific name is derived from the Greek *xanthos* meaning yellow and the Greek *stiktos* meaning spotted, and alludes to the diagnostic yellow spots on the flanks and thighs.

Hyla pseudopuma infucata new subspecies

Plate 17

Holotype.—Adult male, KU 101770 from the Río Changena, Bocas del Toro Province, Panamá, elevation 830 meters; obtained May 18, 1966, by William E. Duellman.

Paratypes.—KU 101771-80; MCZ 55251-2, and UMMZ 126811-12, same locality; collected May 18-22, 1966, by William E. Duellman.

Diagnosis.—A subspecies of *Hyla pseudopuma* characterized by having dark red, instead of yellow, in groin and on anterior and posterior surfaces of thighs; white stripe above anal opening; and blunt snout.

Description of holotype.—Adult male having a snout-vent length of 37.8 mm.; tibia length 20.6 mm., 54.4 per cent of snout-vent length; foot length (measured from proximal edge of inner metatarsal tubercle) 18.6 mm., 49.2 per cent of snout-vent length; head length 11.9 mm., 31.4 per cent of snout-vent length; head width 11.4 mm., 30.1 per cent of snout-vent length. Snout in lateral profile bluntly rounded, in dorsal profile truncate; canthus rounded;

loreal region barely concave; lips thick, moderately flared. Snout short, distance from anterior corner of eye to nostril equal to about three-fourths diameter of eye; nostrils slightly protuberant, directed dorsolaterally; internarial distance 2.6 mm.; internarial area not depressed; top of head flat; interorbital distance 3.8 mm., 33.3 per cent of width of head; width of eyelid 3.2 mm., 28.2 per cent of width of head. Eye large, protuberant, diameter 4.3 mm.; thin dermal fold extending posteriorly from posterior corner of eye, obscuring upper edge of tympanum, curving downward to point above insertion of arm. Tympanum distinct except dorsally, its diameter 51.1 per cent that of eye, separated from eye by distance equal to diameter of tympanum.

Axillary membrane absent; arms moderately robust; dermal fold on outer edge of forearm indistinct, interrupted; transverse fold on wrist weak; fingers short, stocky; length of fingers from shortest to longest, 1-2-4-3; discs large, width of that on third finger 2.6 mm., larger than tympanum; subarticular tubercles moderately small, flat, none distinctly bifid; supernumerary tubercles conical, present on proximal segments; prepollex enlarged, bearing nuptial excrescence composed of many minute horny spinules; webbing absent between first and second fingers, extending from middle of antepenultimate phalanx of second to base of antepenultimate phalanx of third and beyond to base of penultimate phalanx of fourth finger. Heels overlap by about one-third length of tarsus when hind limbs adpressed; tibiotarsal articulation extends to anterior corner of eye; transverse dermal fold on heel; tarsal fold absent; inner metatarsal tubercle long, elliptical, flat, barely visible from above; outer metatarsal tubercle small, conical; toes moderately long, stout; length of toes from shortest to longest, 1-2-3-5-4; discs nearly as large as those on fingers; subarticular tubercles small, flat; supernumerary tubercles large, conical, pigmented, in single row on proximal segments of each toe; toes about two-thirds webbed; webbing extending from distal end of penultimate phalanx of first toe to base of penultimate phalanx of second, from distal end of penultimate phalanx of second to middle of antepenultimate of third, from distal end of penultimate phalanx of third to base of penultimate of fourth to distal end of penultimate of fifth toe.

Anal opening directed posteriorly at level of upper surfaces of thighs, bordered below by vertical flesh folds; anal sheath absent. Skin of belly, ventral surfaces of arms, and proximal posteroventral surfaces of thighs granular, elsewhere smooth. Tongue ovoid, about twice as long as wide, shallowly notched posteriorly, barely free behind. Prevomerine teeth 5-6, situated on transverse ridges between posterior borders of small round choanae. Vocal slit extending from midlateral edge of tongue to angle of jaw.

Color (in preservative): dorsum grayish tan with large brown blotch extending from eyelids to middle of back, limbs marked with brown transverse bars, 2 on each forearm, 3 on each thigh, shank, and foot. Flanks dark gray with white spots; groin, anterior and posterior surfaces of thighs, ventral surfaces of shanks, and inner edges of feet orange-tan; anal region dark brown, bordered above by white stripe; belly and chin creamy white, latter with grayish brown flecks.

Color (in life): dorsum yellowish tan with olive-brown markings by night and uniform pale yellowish tan by day; axilla, inner surface of elbow, groin, anterior and posterior surfaces of thighs, ventral surfaces of thighs and shanks, inner surfaces of feet, and dorsal surfaces of first three toes tomato red; flanks

dark blue with yellow spots and reticulations. Throat, chest, and anterior part of belly creamy white; posterior part of belly orange, becoming red in extreme posterior region; throat flecked with brown; iris pale bronze with black reticulations; palpebral membrane clear above, yellowish tan below; nuptial excrescences dark brown.

Variation.—The discussion of variation is based on the type series plus 31 specimens (KU 101781-811) from the Río Claro near its junction with the Río Changena, at an elevation of 910 meters. Females are slightly larger than males, but do not differ significantly in proportions (Table 1). All specimens have the diagnostic red legs and blue flanks with yellow spots or mottling, but the dorsal pattern is highly variable. In most individuals the dark markings on the dorsum are a solid color, but in some the borders of the marks are dark, and the interior of each mark is nearly the same color as the rest of the dorsum. A triangular dark mark with the anterolateral corners on the eyelids is present in all specimens. In some individuals the posteriorly directed apex of this triangular mark is connected to the apex of another triangular mark on the back; in other individuals the marks are narrowly separated, whereas in a few specimens the marks are broadly connected. A dark blotch usually is present on the posterior end of the body. One specimen (KU 101771) has many small white spots on the dorsum. The white stripe above the anus is invariably present, and the transverse bars on the limbs are present in all specimens, although they are indistinct in some individuals. The pattern on the flanks varies from three or four large spots to many (30-44) small spots. All males have dark flecks or reticulations on the throat; in some individuals the chest and belly are heavily flecked. Although the amount of flecking is much less in most females, one individual is as heavily flecked on the throat and belly as any male.

The change in coloration in this frog is noteworthy. The following description of metachrosis in seven specimens from the Río Claro illustrates the change. At night the frogs were yellowish tan above with slightly darker dorsal markings. The axilla, groin, anterior and posterior surfaces of the thighs, ventral surfaces of the hind limbs, and webbing on the hands and feet were tomato red. By day, some individuals became creamy yellow, others ashy white, and others grayish tan. The flanks were dark blue with yellow spots.

Comparisons.—The population of frogs described here closely resembles *Hyla pseudopuma* Günther in the highlands of Costa Rica. Both have the same kind of, and variation in, dorsal markings; conical, pigmented supernumerary tubercles on the toes; bilobate vocal sac; and large prepollex bearing horny nuptial spinules. Although at present no evidence for intergradation exists, the population described here is considered to be a subspecies of *Hyla pseudopuma*.

The two subspecies exhibit few differences in size and proportions, except that the tympanum is larger in *pseudopuma* (Table 1). *Hyla p. pseudopuma* has dark brown or yellowish tan thighs and brown flanks with a few creamy white spots; the groin in some specimens is pale blue. The red color on the limbs characteristic of *infucata* is lacking in *pseudopuma*, which also lacks the white stripe above the anus characteristic of *infucata*. The only noticeable morphological difference between the subspecies, except in the size of the tympanum, is the shape of the snout. In *infucata* the snout is bluntly rounded in lateral profile and truncate in dorsal profile, whereas in *pseudopuma* the

TABLE 1.—Variation in Certain Measurements and Proportions in the Subspecies of *Hyla pseudopuma*. (Means Are Given in Parentheses Below the Observed Range.)

SUBSPECIES	Sex	N	Snout-vent length	Tibia length / S-V L	Foot length / S-V L	Tympanum / eye
<i>H. p. pseudopuma</i>	♂	31	37.6–41.4 (39.7)	48.5–55.0 (51.5)	44.7–52.9 (48.2)	47.6–66.7 (57.6)
<i>H. p. infucata</i>	♂	31	37.6–42.9 (39.5)	50.7–56.9 (53.4)	43.3–49.5 (47.4)	41.8–55.3 (49.2)
<i>H. p. pseudopuma</i>	♀	11	41.6–47.6 (44.3)	49.1–53.8 (51.7)	45.4–49.5 (47.6)	57.9–71.4 (60.2)
<i>H. p. infucata</i>	♀	11	41.1–45.6 (42.6)	50.0–55.4 (52.6)	43.5–47.4 (45.8)	47.6–56.1 (50.1)

snout is more acutely rounded in lateral profile and acuminate in dorsal profile (Fig. 1). This external difference is correlated with the nature of the underlying premaxillaries. In *infucata* the premaxillaries lie in a transverse plane and have short, nearly vertical alary processes, whereas in *pseudopuma* the premaxillaries lie at a slight angle and have longer alary processes that are inclined posteriorly.

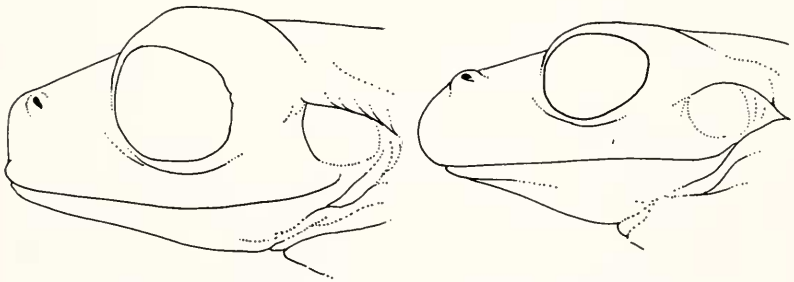


FIG. 1. Lateral views of the heads of *Hyla pseudopuma pseudopuma* (left, KU 64884) and *H. p. infucata* (right, KU 101784). $\times 4$.

The only other frog in Central America having red webs and anterior and posterior surfaces of the thighs is *Hyla loquax*, which has a broad head, extensive axillary membrane, single median vocal sac, and uniformly creamy yellow flanks; furthermore, *loquax* lacks conical, pigmented supernumerary tubercles on the toes and a large prepollex with horny nuptial spinules. *Hyla rufitela* has red webbing, but in no other diagnostic feature resembles *infucata*, for *rufitela* is green above, white below, and has angular prevomerine denticerous ridges.

Remarks.—Most specimens of *Hyla pseudopuma infucata* were found on

bushes and low trees at night. Three males and one clasping pair were on the ground. The habitat is humid lower montane forest where the amount of rainfall is high. Although no breeding was observed nor calls heard, it is presumed that this subspecies breeds in shallow, temporary pools, like those utilized by the nominate subspecies.

The two localities where *Hyla pseudopuma infucata* is known are in the maze of ridges north of Cerro Pando on the Panamanian-Costa Rican border. The Río Claro is a tributary of the Río Changena, in turn a tributary of the Río Changuinola, which receives many streams and rivers draining the northern slopes of the highlands in Bocas del Toro Province before flowing into the Caribbean. We reached the Río Claro and Río Changena by walking from Finca Santa Clara on the Pacific slopes, over the continental divide, and down the north slope of Cerro Pando.

The subspecific name is derived from the Latin *infucatus*, meaning painted, in allusion to the red colors on the limbs and webs.

Hyla pellita new species

Plate 18

Holotype.—Adult male, KU 100970 from 33 kilometers north of San Gabriel Mixtepec, Oaxaca, México, elevation 1675 meters; obtained on February 20, 1966, by William E. Duellman and Linda Trueb.

Paratypes.—KU 100971-2 collected with the holotype and KU 100974-5 from 30 kilometers north of San Gabriel Mixtepec, Oaxaca, México, elevation 1530 meters; same date and collectors.

Diagnosis.—A small yellowish tan *Hyla* characterized by tympanum concealed, anal opening not bordered below by large tubercles, brown bands on shanks, and dark flecks on roof of mouth anteriorly.

Description of holotype.—Adult male having snout-vent length of 27.3 mm.; tibia length 13.7 mm., 50.2 per cent of snout-vent length; foot length (measured from proximal edge of inner metatarsal tubercle to tip of longest toe) 11.7 mm., 42.9 per cent of snout-vent length; head length 8.7 mm., 31.9 per cent of snout-vent length. Snout in lateral profile truncate, rounded above, in dorsal profile rounded; canthus angular; loreal region slightly concave; lips thin, flared. Snout moderately long, distance from anterior corner of eye to nostril slightly less than diameter of eye; nostrils slightly protuberant, directed anterolaterally; internarial area barely depressed; distance between nostrils 2.6 mm.; top of head flat; interorbital distance 3.2 mm., 34.4 per cent of width of head. Diameter of eye 2.7 mm.; thin dermal fold extending from posterior corner of eye to point above insertion of arm; tympanum absent, not visible through skin.

Axillary membrane absent; forearms moderately slender, having indistinct tuberculate fold on ventrolateral edge, lacking distinct transverse fold on wrist; fingers short; length of fingers from shortest to longest, 1-4-2-3, fourth nearly as long as second; discs small, about half again as wide as digits; subarticular tubercles large, round, flattened, distal ones on third and fourth fingers bifid; supernumerary tubercles large, round, present only on proximal segments; prepollex barely enlarged, lacking nuptial excrescence. Web lacking between first and second fingers, extending from base of penultimate phalanx of second to

base of antepenultimate phalanx of third, from middle of antepenultimate phalanx of third to distal end of antepenultimate of fourth finger. Heels overlap by about one-fifth length of shank when hind limbs adpressed; tibiotarsal articulation extending to middle of eye, tarsal fold present, extending full length of tarsus; inner metatarsal tubercle flat, ovoid, partly visible from above; outer metatarsal tubercle absent; toes short; length of toes from shortest to longest, 1-2-3-5-4; discs small, about two-thirds width of those on fingers; subarticular tubercles small, round; supernumerary tubercles small, flattened, irregularly arranged on proximal segments. Toes three-fourth webbed; web extending from base of disc of first to middle of penultimate phalanx of second, from base of disc of second to middle of penultimate phalanx of third, from base of disc of third to base of penultimate phalanx of fourth and to base of disc of fifth toe.

Anal opening directed posteriorly at level of dorsal surfaces of thighs, bordered below by vertical dermal folds and few small tubercles; anal sheath absent. Skin heavily granular on throat, chest, belly and ventral surfaces of thighs, smooth elsewhere. Tongue cordiform, deeply notched posteriorly, barely free behind. Prevomerine teeth 3-4, situated on short elevations between small round choanae; vocal slits absent.

Color (in preservative): pale tan above with dark brown mark in occipital region and large irregular brown mark extending from scapular region to sacral region; anterior and posterior surfaces of thighs and flanks lacking pigment; dorsal surfaces of arms, shanks, and feet tan with brown transverse bars (two on each forearm, two on left shank, one on right shank, and one on each foot); entire dorsal surfaces, except hands and first four toes, peppered with black; venter creamy white; roof of mouth between, and anterior to, choanae speckled with minute black flecks.

Color (in life): yellowish tan above with reddish brown flecks (later changed to pale brown with dull olive-green interorbital bar, blotch on back, and flecks on dorsum); hands, feet, and anterior and posterior surfaces of thighs dull yellow; belly white; creamy white stripes on outer edge of forearm, foot, and above anus; iris pale silver-bronze.

Variation.—Three adult males (including holotype) have snout-vent lengths of 25.2-27.3 (mean 26.5) mm., and two females have 28.6 and 31.6 (mean 30.1) mm. One juvenile has a snout-vent length of 21.5 mm. No significant variation occurs in the proportions. Males have 6-8, and females have 8 and 9, prevomerine teeth. The tympanum is completely concealed in all specimens.

All specimens have distinct transverse bars on the limbs; the number of bars on the shank varies from one to four. Two individuals are dark brown dorsally; in these the small black flecks either are not visible or are absent; flecks are present on the dorsal surfaces of four specimens that are tan or pale brown above with darker brown irregular markings.

The coloration in life consisted of olive-green or olive-brown markings on the body and olive-green or brown bars on the limbs. The dorsal ground color was yellowish tan or pale brown in all individuals.

Comparisons.—*Hyla pellita* differs from all known Middle American *Hyla*, except *mixe*, *mixomaculata*, *nubicola*, and *pimorum*, by having a concealed tympanum. The first three of these differ from *pellita* in greater size and by having many bands on the hind limbs. Superficially *H. pellita* resembles *Hyla*

pinorum, which likewise has a tan dorsum with irregular markings and limbs with transverse bars. *Hyla pinorum* differs from *pellita* by having a proportionately larger head, no transverse bands on the thighs, and large tubercles below the anus. Furthermore, in *pinorum* the quadratojugal articulates with the maxillary, whereas in *pellita* the quadratojugal is reduced to a small spur and does not articulate with the maxillary.

Remarks.—All individuals were found on low vegetation along streams in cloud forest at night. No specimens were found when the type locality was revisited in August, 1966.

Duellman (1960) placed *Hyla pinorum* Taylor in the synonymy of *Ptychohyla leonhardschultzei* Ahl. At that time only the holotype, a female, of *H. pinorum* was known. In 1964 Kraig Adler and I independently collected frogs and associated tadpoles in Guerrero that subsequently proved to be *Hyla pinorum* and provided evidence that *Hyla pinorum* is not conspecific with *Ptychohyla leonhardschultzei*.

The specific name *pellita* is Latin, meaning covered with skin, and is here used in reference to the complete concealment of the tympanum beneath the skin.

Hyla siopela new species

Plate 18

Holotype.—Adult male, KU 100981, from a small stream on the west slope of Cofre de Perote, Veracruz, México, elevation 2500-2550 meters; obtained on July 30, 1966, by William E. Duellman.

Paratypes.—KU 100976-80, 100982-5, same locality, date, and collector; KU 105628-9, same locality, obtained on June 18, 1966, by Howard L. Freeman; UIMNH 57687-57701, same locality, obtained on July 30-31, 1964, by Macreay J. Landy and John D. Lynch.

Diagnosis.—A member of the *Hyla bistincta* group characterized by truncate snout with short rostral keel; fingers having little webbing and bearing large discs; axillary membrane absent; thoracic fold weak; prepollex large, flat, bearing small nuptial spines; vocal slits absent; dorsum green or tan with small irregular dark spots; flanks mottled.

Description of holotype.—Adult male having a snout-vent length of 44.3 mm.; tibia length 21.1 mm., 47.6 per cent of snout-vent length; foot length (measured from proximal edge of inner metatarsal tubercle to tip of longest toe) 20.4 mm., 47.2 per cent of snout-vent length; head length 13.4 mm., 30.2 per cent of snout-vent length; head width 13.7 mm., 30.9 per cent of snout-vent length. Snout in lateral profile truncate, in dorsal profile truncate with weak vertical rostral keel; canthus angular; loreal region slightly concave; lips thick, not flaring; snout short; nostrils barely protuberant, directed dorsolaterally, situated about four-fifths distance from anterior corner of eye to tip of snout; internarial distance 3.6 mm.; internarial area not depressed; top of head slightly convex; interorbital distance 4.9 mm., 35.8 per cent of width of head; width of eyelid 3.5 mm., 26.0 per cent of width of head. Diameter of eye 4.7 mm.; heavy dermal fold curving posteroventrally from posterior corner of eye, covering upper one-third of tympanum, to insertion of arm; tympanum barely distinct, its diameter 2.2 mm., 46.8 per cent that of eye, separated from eye by distance equal to half again diameter of tympanum.

Axillary membrane absent; thoracic fold weak; arms moderately robust; fold on wrist heavy; fingers long, slender; length of fingers from shortest to longest, 1-2-4-3; discs large, that on third finger as large as tympanum; subarticular tubercles moderately small, round, none bifid; supernumerary tubercles small, some barely distinguishable, in single row on proximal segment of each digit; prepollex greatly enlarged, flat ventrally, bearing nuptial excrescence composed of minute horny spinules; webbing between first two fingers vestigial; web connecting other fingers at bases of penultimate phalanges of second and fourth, and base of antepenultimate phalanx of third fingers. Heels overlap by about one-third length of shank when hind limbs adpressed; tibiotarsal articulation extends to posterior edge of orbit; transverse dermal fold on heel; tarsal fold thin, distinct, extending length of tarsus; inner metatarsal tubercle large, elongate, flat, visible from above; outer metatarsal tubercle absent; toes moderately long, slender; length of toes from shortest to longest, 1-2-3-5-4; discs slightly smaller than those on fingers; subarticular tubercles moderately small, round; supernumerary tubercles small, in single row on proximal segment of each digit; toes about two-thirds webbed; webbing extends from middle of penultimate phalanx of first toe to base of penultimate phalanx of second, from middle of penultimate of second to middle of antepenultimate of third, from middle of penultimate of third to middle of antepenultimate of fourth to middle of penultimate phalanx of fifth toe.

Anal opening directed posteriorly at level of mid-thigh; anal sheath short. Skin granular on chin, belly, and posteroventral surfaces of thighs, smooth elsewhere. Tongue broadly cordiform, notched posteriorly, barely free behind. Prevomerine teeth 4-4, situated on posteromedially inclined elevations between small ovoid choanae. Vocal slits absent.

Color (in preservative): dull grayish brown above with small, irregularly-shaped black spots on head, back, and limbs; flanks gray mottled with creamy tan; anterior and posterior surfaces of thighs tan; belly dull creamy tan; throat marked with gray blotches; anal region and posterodorsal surfaces of thighs marked with small white spots.

Color (in life): dorsum pale green with black spots and reticulations; flanks mottled dark brown and creamy white; outer edges of feet silvery white with brown spots; anterior and posterior surfaces of thighs dull brown; webbing and first three toes dull yellowish tan; belly creamy gray; throat silvery white, mottled with gray; iris dull bronze-color with black reticulations; palpebral membrane clear.

Variation.—The snout-vent length in seven adult males is 47.2-50.0 mm., and in five females, 45.1-52.5 mm. In neither sex do the average proportions differ noticeably from those of the holotype, except that the tympanum is relatively larger in females. The ratio of the diameter of the tympanum to that of the eye is 0.363-0.468 (mean 0.438) in males and 0.500-0.545 (mean 0.516) in females. The average number of prevomerine teeth in males is 7.9, in females 8.4.

In life dorsal coloration varied from pale green to olive-green with darker green or black flecks or reticulations, or pinkish tan to brown with dark brown flecks or reticulations. Some preserved specimens have relatively few dark flecks, whereas in most specimens the dorsum is heavily marked. All specimens have some white markings above the anus and on the posterodorsal sur-

faces of the thighs, but in some individuals the white flecks are expanded and interconnected forming an irregular white line.

Juveniles have a notably different coloration in life. The dorsum is uniform pale green; the anterior and posterior surfaces of the thighs, fingers, first three toes, and webbing are deep yellow. The anal stripe is creamy white, and the flanks are pale gray with black flecks. The upper lip, supratympanic fold, and cantial stripe are a bronze color. The belly is pale yellow with a silvery cast on the throat. Juveniles having snout-vent lengths from 24.5 to 36.6 mm. are so colored in life, and uniform dark bluish gray dorsally in preservative.

Comparisons.—The absence of a quadratojugal and the presence of a greatly enlarged, non-projecting prepollex place *Hyla siopela* in the *Hyla bistincta* group (see Duellman, 1964, and Adler, 1965). The presence of a rostral keel separates *Hyla siopela* from other members of the *Hyla bistincta* group, which is composed of two species having long anal sheaths (*bistincta* and *pentheter*), two small species having axillary membranes and lacking nuptial excrescences in breeding males (*charadricola* and *chryses*), and three species (*crassa*, *pachyderma*, and *robertsorum*) having short heads, round snouts, short anal sheaths, and nuptial excrescences in breeding males. *Hyla siopela* differs from the last three species in the shape of the snout and from each in certain structural features: *H. crassa* has fully webbed feet; *H. pachyderma* has large nuptial spines, and *H. robertsorum* has more webbing and a shorter tarsal fold. Furthermore, the venter in *H. robertsorum* is brown with creamy white flecks.

In structure and coloration *H. arborescendens* resembles *siopela*, but the former is smaller, and males of *arborescendens* have vocal slits.

Remarks.—This description brings to eight the number of species now recognized in the *Hyla bistincta* group. *Hyla siopela* is most closely related to *Hyla robertsorum* from the high mountains of the Sierra Madre Oriental in northern Puebla and eastern Hidalgo. Possibly the four species now recognized in the *crassa* subgroup (*crassa*, *pachyderma*, *robertsorum*, and *siopela*) are only subspecies of a single species, but differences in the amount of webbing in *crassa* and the nature of the nuptial excrescences in *pachyderma* indicate that they are distinct species.

The type locality of *Hyla siopela* is a small stream cascading down the western slope of Cofre de Perote; the lower reaches of the stream can be reached by a dirt road leading east from the village of Perote for about 2 kilometers to a small park. The frogs were found in the stream at elevations of 50 to 100 meters higher than the park. The stream flows through a ravine supporting open, dry pine forest. Although the stream was searched thoroughly in February, 1966, no frogs were found. In July, 1966, adults and juveniles were found in crevices and under overhanging rocks behind small cascades and waterfalls by day and sitting on rocks and branches in the spray of cascades at night.

The specific name *siopela* is derived from the Greek *siopclos*, meaning silent, and alludes to the absence of a voice in this species.

Hyla altipotens new species

Plate 19

Holotype.—Adult male, KU I01001, from 37 kilometers (by road) north of San Gabriel Mixtepec (kilometer post 183 on road from Oaxaca to Puerto

Escondido). Oaxaca, México, elevation 1860 meters; obtained on February 19, 1966, by William E. Duellman.

Paratypes.—KU 101002-6 collected at the same locality on February 19 and 20, 1966, by William E. Duellman, and KU 101008 from 33 kilometers (by road) north of San Gabriel Mixtepec, Oaxaca, México, elevation 1675 meters; obtained on February 20, 1966, by Linda Trueb.

Diagnosis.—A member of the *Hyla taeniopus* group characterized by a yellow venter, yellow flecks on posterior surfaces of thighs, bronze-colored stripe from snout, along canthus and edge of upper eyelid to point above arm, pointed snout, smooth dorsum, and no sexual dimorphism in shape of snout.

Description of holotype.—Adult male having a snout-vent length of 68.8 mm.; tibia length 36.2 mm., 52.6 per cent of snout-vent length; foot length (measured from proximal edge of inner metatarsal tubercle) 31.1 mm., 45.2 per cent of snout-vent length; head length 20.2 mm., 29.4 per cent of snout-vent length; head width 20.0 mm., 29.1 per cent of snout-vent length. Snout in lateral profile acutely rounded, protruding beyond tip of lower jaw, in dorsal profile pointed; canthus angular; loreal region flat; lips thick, barely flared. Snout long; nostrils slightly protuberant, directed dorsolaterally, situated about two-thirds distance from anterior corner of eye to tip of snout; internarial distance 5.6 mm.; internarial area slightly depressed; top of head flat; interorbital distance 6.0 mm., 30.0 per cent of width of head; width of eyelid 4.7 mm., 23.5 per cent of width of head. Diameter of eye 6.2 mm.; heavy dermal fold extending from posterior corner of eye, over upper edge of tympanum to point above insertion of arm; tympanum distinct, its diameter 3.4 mm., 54.8 per cent of that of the eye, separated from eye by distance equal to diameter of tympanum.

Axillary membrane absent; arms moderately robust, lacking dermal fold on lateral edge of forearm, having transverse fold on wrist; fingers moderately short, broad; length of fingers from shortest to longest, 1-2-4-3; discs large, that on third finger one-fourth larger than tympanum; subarticular tubercles large, round, none bifid; supernumerary tubercles large, granulelike, present only on proximal segments; prepollex enlarged, not bearing nuptial excrescence. Fingers about one-half webbed; webbing connects first and second fingers at level of distal end of antepenultimate phalanx, extending from middle of penultimate phalanx of second finger to middle of antepenultimate phalanx of third, and between bases of penultimate phalanges of third and fourth fingers. Heels overlap by about one-half length of shank when hind limbs adpressed; tibiotarsal articulation extends to point between eye and nostril; thin transverse dermal fold on heel; tarsal fold strong, extending full length of tarsus; inner metatarsal tubercle small, flat, elongate, barely visible from above; outer metatarsal tubercle small, conical; toes moderately long, stout; length of toes from shortest to longest, 1-2-3-5-4; discs slightly smaller than those on fingers; subarticular tubercles large, round, subconical; supernumerary tubercles large, conical, in single row on proximal segment of each digit; toes about four-fifths webbed; webbing extending from base of disc on first to base of disc on second to base of penultimate phalanx of third toe, from base of disc on third to base of penultimate phalanx of fourth to base of disc of fifth toe.

Anal opening directed posteroventrally at midlevel of thighs; anal sheath long, tubular. Skin smooth on dorsum and on ventral surfaces of shanks,

granular on throat, belly, and ventral surfaces of arms and thighs. Tongue ovoid, widest posteriorly, neither notched nor free behind. Prevomerine teeth 6-7, situated on robust transverse ridges between small, ovoid choanae. Vocal slits absent. Testes large, ovoid, granular; length of left testis 11.0 mm.

Color (in preservative): brown above with many darker brown spots and narrow middorsal stripe on back; six or seven dark brown transverse bars on each segment of hind limbs and four bars on each forearm; flanks white with dark brown spots; anterior surfaces of thighs creamy white with brown reticulations; posterior surfaces of thighs dark brown with creamy yellow flecks; stripe on snout, canthus, edge of upper eyelid, and supratympanic fold tan; ventral surfaces of feet brown; rest of venter creamy white; stripe above anus white.

Color (in life): green above with slightly darker green spots; dorsal surfaces of upper arms and thighs tan with green transverse bars; upper surfaces of forearms and shanks green with darker green transverse bars; feet, fourth and fifth toes, and third and fourth fingers tan with brown transverse bars; other fingers and toes tan with brown flecks. Ventral surfaces creamy yellow, brightest on throat and chest; flanks and anterior surfaces of thighs bright creamy yellow with dark brown reticulations and spots; posterior surfaces of thighs and ventral surfaces of feet dark brown with yellow flecks; ventral surfaces of hands and webbing on hands and feet yellowish tan. Labial stripe tan; stripes on outer edge of forearm, along outer edge of foot, and above anus cream-color; stripe on canthus, edge of upper eyelid, and on supratympanic fold bronze-color. Iris pale bronze with black reticulations and faint median, horizontal copper-colored streak; pupil horizontally elliptical with ventral notch; palpebral membrane clear above, pale bluish green with brown reticulations below.

Variation.—In life all individuals had creamy yellow venters and yellow flanks and anterior surfaces of thighs with brown or black spots and mottling. Most of the adults were colored like the holotype, but one was a much darker olive-green, and one was uniform brown above with a dark brown middorsal stripe. Most subadults (snout-vent lengths 31.6-50.1 mm.) were pale reddish tan above with darker reddish brown bars on the limbs and blotches on the back. The side of the head was dark brown and the stripe along the canthus, edge of upper eyelid, and supratympanic fold was yellowish tan. Some individuals had a dark brown middorsal stripe. The posterior surfaces of the

TABLE 2.—Variation in Measurements and Proportions in *Hyla altipotens*. (Means Are Given in Parentheses Below the Observed Range.)

SEX	N	Snout-vent length	Tibia length/S-V L	Foot length/S-V L	Tympanum/eye
Males.....	5	68.8-75.1 (70.7)	52.6-55.8 (53.7)	28.1-30.0 (29.2)	41.4-55.2 (50.6)
Females.....	2	69.4-75.3 (72.4)	55.8-56.2 (56.0)	28.8-31.1 (29.9)	53.3-63.0 (58.8)

thighs were dull yellowish tan; yellow flecks were present in the larger individuals.

The number of transverse bars on each thigh and shank varies from five to eight. The white stripe above the anus and the stripe from the snout along the side of the head are invariably present. In some of the largest individuals the brown reticulations on the anterior surface of the thigh extend onto the ventral surface; in these specimens brown flecks are present on the ventral surfaces on the shanks.

The tympanum is proportionately larger in females than in males; the variation in size and proportions is given in Table 2. The total number of prevomerine teeth varies from 13 to 18 (mean, 15) in five adult males and from 10 to 12 (mean 11) in two females.

The testes in all adult males are granular, ovoid in shape, and greatly enlarged. The lengths of the left testis in each of the five males are 11.0 to 23.5 (mean 14.6) mm.

Comparisons.—On the basis of external appearance and certain cranial characters (large frontoparietal fontanelle, broad splenethmoid, large nasals broadly separated medially having thin lateral processes articulating with the palatines, short squamosal not articulating with the maxillary, and quadratojugal present and articulating with the maxillary), *Hyla altipotens* can be associated with the *Hyla taeniopus* group (Duellman, 1965, Lynch and Smith, 1966). *Hyla altipotens* can be distinguished from all of the other members of the group by its narrow head, pointed snout in both sexes, and uniformly yellow throat and belly.

Small brown individuals of *Hyla altipotens* superficially resemble adult *Hyla pinorum*. The latter species has a covered tympanum, less webbing on the hands, and a short, blunt snout.

Remarks.—This stream-breeding frog is like *Hyla taeniopus* in having greatly enlarged testes, which possibly through the production of vast quantities of sperm are an adaptation for successful breeding in torrential streams (Duellman, 1965:164).

All individuals were found in trees and bushes near streams in cloud forest at night in February. The type locality is the same as that of *Hyla pentheter* and *Hyla thorectes*, discovered by Kraig Adler in June, 1964. Our field work there in February, 1966, resulted in finding *Hyla altipotens*, *H. pellita*, and *Ptychohyla leonhardschultzei*, but no individuals of the species found by Adler. A visit to the same locality in August, 1966, revealed no individuals of either *H. altipotens* or *pellita*; instead *pentheter* and *thorectes* were found along the stream.

Duellman (1965:166) listed a specimen (TCWC 16184) of *Hyla chaneque* from Los Fustes, 3 kilometers east of San Sebastian, Oaxaca. Reëxamination of this specimen reveals that it is *Hyla altipotens*. The frog was obtained by Dillard Carter on April 29, 1960; it was under a rock at the edge of a stream in an oak-pine-cypress association at an elevation of 1800 meters.

The specific name *altipotens* is Latin, meaning mighty, here used in allusion to the supposed potentiality of fertilization by the production of vast quantities of sperm in the large testes.

Plectrohyla hartwegi new species

Plate 19

Holotype.—Adult male, UMMZ 94428, from Barrejón (19 kilometers west of Chicomuselo), Chiapas, México, elevation 1000 meters, obtained on June 12, 1941, by Eizi Matuda.

Paratypes.—Two subadult males, KU 58873 from Parajé El Triunfo, north of Mapastepec, Chiapas, México, elevation 2050 meters, obtained on May 12, 1960, by Miguel Alvarez del Toro, and UIMNH 40837 from Cerro Azul Oaxaca, México, obtained on March 7, 1956, by Thomas MacDougall.

Diagnosis.—A *Plectrohyla* having a bifid prepollex, bold mottling on flank and ventral surfaces of shanks, and vertical dark bars on anterior and posterior surfaces of thighs, and lacking vocal slits and outer tarsal fold.

Description of holotype.—Adult male having a snout-vent length of 63.8 mm.; tibia length 34.9 mm., 54.7 per cent of snout-vent length; foot length (measured from proximal edge of inner metatarsal tubercle to tip of longest toe) 31.1 mm., 48.7 per cent of snout-vent length; head length 19.7 mm., 30.9 per cent of snout-vent length; head width 22.6 mm., 35.4 per cent of snout-vent length. Snout short, distance from level of anterior edge of orbit to tip of snout 70.6 per cent of length of eye; snout in lateral profile angular, sloping abruptly from nostrils to jaw, in dorsal profile bluntly rounded, lacking rostral keel; canthal ridge thickened; loreal region deeply concave; lips thick, barely flared. Nostrils small, barely protuberant, directed anterolaterally, situated about two-thirds distance from eye to tip of snout; internarial distance 5.6 mm. internarial area barely depressed near convergence of canthal ridges; top of head flat; interorbital distance 6.4 mm., 28.3 per cent of head width; diameter of eye 6.8 mm.; width of eyelid 5.5 mm., 24.3 per cent of head width. Heavy dermal fold extending posteriorly from posterior edge of orbit, covering upper edge of tympanum; two thinner folds extending ventrally from longitudinal heavy fold covering posterior edge of tympanum; anterior and ventral edges of tympanum distinct; length of tympanum 2.9 mm., 42.6 per cent of diameter of eye.

Axillary membrane absent; arms robust, forearm not noticeably heavier than upper arm; distinct transverse fold on wrist. Fingers long, moderately slender; length of fingers from shortest to longest, 1-2-4-3; discs moderately large, that on third finger larger than tympanum; webbing vestigial; subarticular tubercles small, conical; terminal tubercle on fourth finger somewhat flattened; supernumerary tubercles small, in one row on proximal segment of fourth finger and in two rows on proximal segments of other fingers; prepollex greatly enlarged, barely bifurcate; spines not protruding through skin; distal spine much longer than proximal one (Fig. 2). Heels overlap by about one-third length of shank when hind limbs adpressed; tibiotarsal articulation extends slightly beyond snout; heavy transverse dermal fold on heel; inner tarsal fold heavy, extending full length of tarsus; outer tarsal fold absent; inner metatarsal tubercle high, elliptical, visible from above, outer metatarsal tubercle absent. Toes long, slender; length of toes from shortest to longest,



FIG. 2. Palmar view of prepollical spine of right hand of *Plectrohyla hartwegi* (UMMZ 94428). $\times 5$.

1-2-5-3-4; fifth toe nearly as long as third; discs small; subarticular tubercles small, round; supernumerary tubercles small, in single row on proximal segment of each digit; toes about three-fourths webbed; webbing extending from base of disc of first toe to base of penultimate phalanx of third, from base of disc of third to base of penultimate phalanx of fourth to base of disc of fifth toe.

Anal opening directed posteroventrally at level of mid-thigh; anal sheath long with membranous connection to posterior surfaces of thighs. Skin on dorsal surfaces finely tuberculate; that on throat, chest, belly, and ventral surfaces of thighs granular, that on ventral surfaces of arms and shanks smooth. Tongue nearly round, free posteriorly for about one-fourth its length, barely notched behind. Upper jaw shallowly notched medially. Maxillary-premaxillary teeth 38-35; prevomerine teeth 5-5, situated on small elliptical elevations between quadrangular choanae; vocal slits absent.

Color (in preservative): uniform dull brown above and creamy yellow below; flanks brown with creamy yellow mottling and dark brown spots in groin; anterior surfaces of thighs creamy yellow with two broad, vertical, dark brown bars proximally and two narrower, dull brown bars distally; posterior surfaces of thighs brown with dark brown vertical bars, interspaces cream-colored or brown. Ventral surfaces of shanks creamy yellow with bold brown reticulations.

Variation.—The paratypes are smaller, having snout-vent lengths of 48.3 and 41.8 mm. In these specimens the ratio of the length of the tibia to the snout-vent length is 55.9 and 57.9 per cent, and the ratio of the diameter of the tympanum to the diameter of the eye is 47.3 and 43.6 per cent, respectively. Both specimens have 4-4 prevomerine teeth; one specimen has 37-36, and the other has 40-37, maxillary-premaxillary teeth. In these small specimens the supratympanic fold is thin, and the arms are not so robust as in the holotype. In one specimen (KU 58873) the tongue is not notched posteriorly. The terminal subarticular tubercle on each fourth finger is broad and flattened in UIMNH 40837, but conical in KU 58873. Both specimens have bold creamy-yellow and dark brown mottling on the flanks and dark brown reticulations on the ventral surfaces of the shanks. There are two dark brown vertical bars on the anterior and posterior surfaces of each thigh in KU 58873 and three bars on each surface in UIMNH 40837.

Comparisons.—*Plectrohyla hartwegi* differs from all known species in the genus by having boldly mottled flanks, dark reticulations on the ventral surfaces of the shanks, and dark vertical bars on the shanks. In all of the other species the anterior and posterior surfaces of the thighs are unmarked, and the flanks are either plain or marked with small spots or flecks. Structurally, *P. hartwegi* belongs in the *guatemalensis* group of the genus, containing *acia*, *glandulosa*, *guatemalensis*, and *pynochila*. The species in this group lack vocal slits and have either large, rectangular, or bifid prepollices. *Plectrohyla hartwegi* differs from all of these species, except *pynochila*, by having a tuberculate, instead of a smooth, dorsum, and *hartwegi* differs from *pynochila* by having a bifid, instead of a rectangular, prepollex.

Remarks.—The known distribution of *Plectrohyla hartwegi* includes three localities at elevations of 1000 to 2050 meters in the Sierra Madre of Chiapas and extreme eastern Oaxaca. The specimen from Parajé El Triunfo was found in a rocky stream in cloud forest at an elevation of 2050 meters. One *Plectrohyla sagorum* was obtained from the same stream.

Eizi Matuda sent the holotype to the late Dr. Norman Hartweg, who recognized that the specimen was unique but was reluctant to name the species on the basis of a single specimen. Now that two additional specimens are available, it seems appropriate to associate Hartweg's name with this new species of *Plectrohyla*, a genus that Hartweg first adequately defined.

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